Abstract

A method for pumping remote optically-pumped fiber amplifiers (ROPAs) in fiber-optic telecommunication systems is disclosed which uses cascaded Raman amplification to increase the maximum amount of pump power that can be delivered to the ROPA. According to the prior art, high power at the ROPA pump wavelength, λp, is launched directly into the fiber and the maximum launch power is limited by the onset of pump depletion by Raman noise and oscillations due to the high Raman gain at ~ (λp +100) nm. In preferred embodiments of the present invention, a 'primary' pump source of wavelength shorter than λp is launched into the delivery fiber along with two or more significantly lower-power 'seed' sources, among which is included one at λp. The wavelength and power of the seed source(s) are chosen such that, when combined with the high-power primary source, a series, n, where $n \geq 2$, of Raman conversions within the fiber ultimately leads to the development of high power at λp. In another embodiment, one or more of the seed sources at wavelengths shorter than λp are replaced by reflecting means to return, into the fiber, backward-travelling amplified spontaneous Raman scattered light resulting from high power in the fiber at a wavelength one Raman shift below the particular seed wavelength. In either case, the high power at λp is developed over a distributed length of the fiber, reaching its maximum some distance into the fiber and exceeding the maximum power possible at that point with the prior art.